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PINE PITCH CANKER
IN
CALIFORNIA

REPORT OF THE INTERAGENCY WORKING GROUP

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SUMMARY

Pitch canker, a major disease of pines in the southeastern United States, was found in the Santa Cruz area in August, 1986. A large infestation exists in Santa Cruz County; smaller infestations have been found in Alameda, Monterey, San Mateo, and Santa Clara Counties.

Immediate implementation of an intensive disease control program, with an accompanying research effort to develop needed information on the disease, is recommended. Necessary quarantines, statewide survey, and ongoing public information work should be part of the program. The entire program should be evaluated annually and modified as needed.

The recommended program is a cooperative approach to the pitch canker infestation. It is intended to preserve our options as we gain additional information to better assess the situation.

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INTRODUCTION

Unusual symptoms of unknown cause were observed on Monterey pines in the Santa Cruz area during the summer of 1986. Subsequent investigation confirmed the presence of a disease previously unknown in California--pine pitch canker, caused by the fungus Fusarium subglutinans.

Survey during the fall and winter months showed the disease to be widespread in the Santa Cruz area; infected Bishop and Aleppo pines, as well as Monterey pines, were identified. Additional infected trees were found in a limited number of locations in Alameda, Monterey, San Mateo, and Santa Clara counties.

Mounting concern led to a public meeting in Felton on December 3, 1986, at which information on the symptoms, biology, and distribution of the disease was presented. Evidence of continuing spread of the pathogen led Dr. Isi A. Siddiqui, Assistant Director of the Division of Plant Industry, California Department of Food and Agriculture (CDFA), to convene an interagency meeting on January 23, 1987, to review and discuss the situation. An Interagency Working Group was formed to continue the review and discussions and to produce a report addressing the following: 1) disease distribution, 2) host range; 3) research needs; 4) recommendation on control; and 5) determine a time frame for decisions by management and the public.

HISTORICAL PERSPECTIVE

"Early in the spring of 1945, dead branches and leaders were observed on many Virginia pines (Pinus virginiana Mill.) on the Bent Creek Experimental Forest of the U.S. Forest Service, near Asheville, North Carolina. At the base of each dead part was a very pitchy canker."[1] Thus began the first description of pine pitch canker, published by Hepting and Roth in 1946. By 1949, the pitch canker fungus had been isolated from several species of southern pines in parts of Virginia, North Carolina, Tennessee, South Carolina, Georgia, Alabama, and Florida.[2] The disease is now considered to be endemic to the southeastern United States[3] where it is described as a major disease of planted pines[4].

While Hepting and Roth[1] stated that there was a very rapid build-up of pitch canker at the Bent Creek site, it should be pointed out that they found the disease at several other sites in North Carolina and South Carolina during 1945. They were also studying, "a pitchy canker of similar appearance on slash pine in Georgia and Florida". Thus, what at first appears to be a rapid spread of pitch canker throughout the southeast from 1945 to 1949 probably occurred over a far greater time span.

The fungus causing pine pitch canker has, as outlined by Dwinell et al.[3], undergone several name changes. Originally placed in the Fusarium section Liseola, it was later designated F. lateritium f. sp. pini. Based on characteristics observed by

researchers in the mid 1970's, the fungus was assigned to *Fusarium moniliforme* var. *subglutinans*. A 1983 proposal raised the variety to species level as *F. subglutinans*.

BIOLOGY

Pine pitch canker, a disease caused by the fungus *Fusarium subglutinans* (FS), has a wide host range among the various species of pine (see Appendix I). Degree of susceptibility varies among the species; resistant individuals are found within species.

Disease symptoms vary depending on the age and species of pine infected. The classic symptom consists of an oozing, resinous or "pitchy" canker on the trunk, large branches, or terminals. The canker is usually sunken, with the bark retained. The wood beneath the canker is discolored and heavily resin-soaked.

Shoot dieback is frequently observed in the upper crown. Girdling of the stem by the canker causes the needles beyond the canker to yellow and turn reddish brown. Dead shoots may remain in the crown for several years.

Diseased pine seedlings may exhibit a variety of symptoms, including chlorotic or reddish brown needles, tip dieback, pitch-soaked lesions, and/or wilting. Infected cones are often smaller, misshapen, and contain fewer viable seeds. It has been demonstrated that FS will infect or infest the pine seeds, as well as the cone.

Pines are infected via fresh wounds. These wounds may range from insect feeding sites to pruning cuts to major storm damage involving broken limbs. Spores of FS may be airborne, waterborne in splashing/dripping rain or fog drip, carried by insect vectors, or moved by man on nursery stock, tools, etc.

Various stress factors, such as drought, may predispose trees to infection. Increased levels of nitrogen fertilizer have reportedly resulted in higher infection rates. As Dwinell et al.[3] pointed out, "Each outbreak in each specific location has its own unique case history (or sequence of events). Care must be taken in extrapolating from one aspect of the disease to another (i.e., shoot dieback vs. trunk cankers and plantations vs. seed orchards)."

Damage produced by FS includes crown dieback, stem deformation, reduced growth, and tree mortality. Additional losses are encountered in seed and cone production and in loss of seedlings, both in the nursery and after outplanting. Considerable damage would also result from the loss of pines in ornamental and recreational plantings.

CONTROL STRATEGIES IN THE SOUTHEASTERN STATES

It should be stated at the outset that there is no specific program to reduce or eliminate the threat of pitch canker. However, an integrated management program, involving the use of chemicals, biological control agents, cultural control, and selection of disease-resistant trees, is being developed[3].

Experimental trials using the fungicide thiabendazole in nursery situations have provided some control. However, field trials with the fungicide benomyl did not provide a significant reduction in disease incidence.

Indirect chemical control of pitch canker, using the insecticides phorate or chlorpyrifos, has reduced the level of disease incidence in field trials. Use of the insecticides is believed to reduce the number of insect vectors and/or insect-caused wounds.

Biological control agents currently being evaluated include Arthrobacter sp., a bacterial antagonist of FS, and Fusarium moniliforme var. moniliforme, which may prove to be a fungal competitor of FS. Neither of these agents has provided effective control of FS in field trials to date.

Cultural control procedures include reducing fertilization levels, careful selection of seed sources, and minimizing tree wounding/damage during cultural operations. Additional

procedures include thinning stands to reduce competitive stress levels, thereby reducing attractiveness to insects. Thinning or salvage operations can also be employed to reduce inoculum levels in areas of high disease incidence.

The search for and evaluation of pine clones resistant to FS is continuing. While other control methods may be economically feasible in intensively managed operations such as Christmas tree farms, nurseries, and seed orchards, selection for resistant varieties will probably become the primary disease control mechanism in southern pine plantations, especially if pitch canker becomes pandemic.

HOST RANGE OF PITCH CANKER IN CALIFORNIA

Known hosts of pitch canker are summarized in Appendix I. Most of these are pines of the southeastern United States. For comparison, a list of native and ornamental pines grown in California is in Appendix IX.

Pines found naturally infected to date in California include Pinus radiata (Monterey pine), P. muricata (Bishop pine), and P. halepensis (Aleppo pine). Greenhouse inoculations indicate that P. sabiniana (Digger pine), P. eldarica (Eldarica pine), P. coulteri (Coulter pine), P. radiata x attenuata, and P. ponderosa (Ponderosa pine) are also susceptible (see Research section for additional information).

A limited infection developed in Abies concolor (white fir) seedlings following inoculation. The small necrotic area which formed around the inoculation point was quickly walled-off with callus tissue by the seedling. White fir would probably not serve as a host of pitch canker in nature.

No infection developed in inoculated seedlings of Calocedrus decurrens (incense cedar), Sequoia sempervirens (coast redwood), or Sequoiadendron giganteum (giant sequoia). Additional host range studies are underway at U.C. Berkeley.

KNOWN DISTRIBUTION OF PITCH CANKER IN CALIFORNIA

Early delimitation survey on the Santa Cruz pitch canker infestation was performed by Dr. Tom Watson, CDFA plant pathologist, in late September, 1986. A more intensive survey of the area was undertaken by personnel from the Dutch Elm Disease Project, CDF, in November, 1986 (Appendix III). Survey in northern California coastal counties was undertaken by Jack Marshall, CDF, in January, 1987 (Appendix IV). Dr. Watson is surveying areas south and east of the current infestation at the present time.

Two levels of survey intensity were used to delimit the presence of pitch canker in and around known areas of infestation. A visual survey was made of trees on all major roads south of San Francisco to Carmel, and through the Salinas and Santa Clara Valleys. More intensive surveys were made within areas of known infestation by driving through most of the streets within an area and recording numbers of symptomatic vs. healthy trees.

Pitch canker has been found in three areas of the central California coastal region: 1) southern Santa Cruz County and northern Monterey County, 2) western Alameda County, and 3) southern San Mateo County and northern Santa Clara County. Maps in Appendix V highlight these areas.

1. Disease distribution in the Santa Cruz area of survey is discontinuous between Santa Cruz and Watsonville. Pitch canker was found to extend from the western city limits of

Santa Cruz to the eastern limits of Seacliff State Beach, as well as in the locales of Freedom, Watsonville, and south to Pajaro and vicinity. The intervening area has many large Monterey pines that are apparently disease-free. However, in Rio del Mar there is a small area of infestation at the intersection of Sumner Avenue and Dolphin Drive. Otherwise, the communities of La Selva Beach, Rio del Mar, and Aptos to the east side of Seacliff State Beach are only lightly infested.

The survey estimated that 24,555 Monterey pine were found throughout this area, with 2,240 (9.1%) trees having symptoms resembling pitch canker (see Appendix II). These figures are estimates only, and are presented here to provide some indication of the overall Monterey pine population and disease levels in the area. The estimates do not include trees along state highways (see Caltrans letter, Appendix VII).

2. The number of diseased trees is much lower in Alameda County than in the Santa Cruz area. Infected trees number about 400, with approximately 3,000 associated healthy trees. Pitch canker is found in three separate areas. The first area is in San Leandro at the junction of Highways 238 and 880 and is comprised of approximately 300 diseased trees. The second area of infestation lies within the city limits of Hayward along Mission Blvd. between Industrial Parkway and

Whipple Road, and contains approximately 90 diseased trees. The third area is found about two and one-half miles west of the Mission Blvd. infestation along the Nimitz Freeway (880). Two infected trees were found there on private property.

3. The southern San Mateo county/northern Santa Clara county area consists of two small infested areas. One tree was confirmed positive at the Sharon Heights Golf and County Club on the north side of the intersection of Highway 280 and Sand Hill Road near Woodside. A second positive was found several miles away on northbound Foothill Expressway between Edith and Arastradero (near Miranda Avenue) in Palo Alto.

CURRENT CONTROL ACTIVITIES IN CALIFORNIA

Several agencies are involved with various control activities at the present time. On-site and classroom training in disease identification are being provided by CDF and CDFA for a number of state and county agencies.

Parks and Recreation plans to remove almost 400 infected pines at New Brighton State Beach and at Natural Bridges State Beach. The pines will be replaced with native oaks as part of their ongoing program of replacing "exotic" (planted) species with vegetation native to the area of the park.

Caltrans is faced with the removal of approximately 1,500 infected trees in the Santa Cruz and Hayward areas. Replacement trees will probably be coast redwood or Douglas fir. Removal of dead and/or dying trees (regardless of cause) is a necessary part of their landscaping maintenance program.

U.S.D.A.-Forest Service is training personnel in pitch canker recognition and management. Although the nearest Forest Service land is over 40 miles away from the current infestation, they believe the disease may prove to be a threat and will assist in efforts to prevent further spread of pitch canker.

See Appendix VII for further information.

RESEARCH ON PITCH CANKER IN CALIFORNIA

(as of February 17, 1987)

A. Plant Pathology - Dr. A.H. McCain, U.C. Berkeley

1. Host range studies: The following conifer seedlings (1-2 years old) will be or have been inoculated with the pitch canker fungus, Fusarium subglutinans: Pinus muricata, P. coulteri, P. eldarica, P. radiata, P. radiata x attenuata, P. sylvestris, P. ponderosa, P. jeffreyi, P. lambertiana, P. pinea, P. halepensis, P. sabinlana, Sequoia sempervirens, Sequoiadendron giganteum, Pseudotsuga menziesii, Calocedrus decurrens, and Abies concolor. Some of the trees are dormant and have not been inoculated.

P. coulteri, P. eldarica, P. radiata x attenuata, P. sabiniana (only 1 tree), P. pinea, and P. radiata (control) have become infected (10/10). Based on the rapid appearance of symptoms, they are all quite susceptible. P. ponderosa also became infected, but was somewhat slower because the trees were dormant. P. halepensis did not become infected. Abies concolor became infected but callus tissue is now forming and the infection will be limited. S. sempervirens, S. giganteum and C. decurrens did not become infected. Additional Pinus species will be obtained and inoculated.

2. Wound susceptibility: In an experiment in the Southeast, wounds were still susceptible after 20 days. A greenhouse trial with P. radiata is underway at UCB.

3. Isolate pathogenicity: Four isolates from the Southeast were compared to the California (Santa Cruz) isolate. They caused shoot necrosis at the same intensity as the California isolate. The rapidity of infection and severity of the disease on P. radiata is not related to the isolate. P. radiata is very susceptible to pitch canker.

4. Seed transmission: Normal-appearing cones were collected from P. radiata with pitch canker infections. On close examination it was determined that the branch and peduncle of one cone was infected. When this cone was opened, sporulation of the fungus was evident on the internal parts and seeds. These seeds were not viable. Another cone appeared normal when opened. Seeds were placed on agar medium and the fungus sporulated on the seed coats. Most of the seeds germinated; some of them in close contact with the contaminated seed coats became infected.

   The fungus is known to be seed-borne in the southeast and also is obviously seed-borne in California.

5. Wound treatment future/recommended research: The fungus requires a wound to infect the host. In a sanitation program to remove infected branches, susceptible wounds are created. Although thiabendazole (Mertect) provided

some control in nurseries and for small trees, it was not effective as a wound treatment. In a preliminary greenhouse trial at UCB, mancozeb, benomyl and thiabendazole failed to protect fresh wounds on P. radiata from infection. Additional fungicides and methods of application should be investigated.

6. Resistant trees: Field observations suggest that there are differences in susceptibility of P. radiata trees. In the Southeast, clones of P. loblolly tolerant to pitch canker have been identified. A research program to identify resistant trees would be of value, particularly if the disease outbreak continues at the current pace.

7. Fungisol injections: Fungisol, a product of J.J. Mauget Co., is registered for use on pine for control of "Pine pitch canker". There are no reports in the literature on the efficacy of the product with respect to the control of pitch canker. Steve Tjosvold, Farm Advisor, Santa Cruz County, plans to evaluate the product, and Art McCain will assist him.

8. Saprophytic activity: Noninfected logs cut from P. radiata and other pines might become infected if invaded by bark beetles carrying the fungus. Emerging beetles may then carry the fungus and infect healthy trees much in the same manner as in the Dutch elm disease. This possibility should be investigated.

9. Seed treatments: Cones should not be collected from infested areas. As an additional precaution, seed treatment may have some value. Dr. Don Ferrin, Department of Plant Pathology, U.C. Riverside is conducting research on seed treatments for another disease of Pinus spp. caused by F. oxysporum. He may be interested in expanding this work to include F. subglutinans.

B. Entomology - Dr. C.S. Koehler, U.C. Berkeley.

The association of insects with the pitch canker disease in California may take one (or both) of two forms. Insects may merely bite into the plant during normal feeding, providing an infection court for the fungus, which is transported there by other means. Or, insects may physically transport spores of the fungus to infection courts opened during the insect's normal feeding, thereby inoculating the tree.

About 50 species of insects are known to feed on Monterey pine in California. Because new pitch canker infections seem to occur in greatest numbers on branch tips and at the point of cone attachment to branches, the most probable vectors are members of the Coleoptera and Lepidoptera.

To date, larvae of two species of California scolytid bark beetles have been taken from beneath the bark of pitch canker infected wood and placed on media. The pitch canker fungus sporulated on three of five larvae, and two of seven larvae, respectively, of these two beetle species. This experience

demonstrates that insects become contaminated by the fungus in nature, but it does not prove that insects serve as vectors in the field.

More than one species of insect may be involved in the pitch canker association. To determine the role of insects in the epidemiology of the disease, the following research is recommended:

1. Insects that feed on Monterey pine in the Santa Cruz infection center should be collected individually using sterile equipment, transported to the laboratory, and placed on appropriate media. Those species that are not found to be contaminated after culturing several dozen individuals of each should be discounted as candidate vectors.
2. Insect species that are demonstrated to be contaminated should be re-collected as above, and placed on healthy pines growing in containers and appropriately caged to prevent insect escape. If infection occurs, it will demonstrate which species are capable of serving as vectors; follow-up caging should be done with these candidate vector species using healthy pine material located in the Santa Cruz area. Cone-infesting insects would have to be caged on field material only, for seedling pines do not produce cones.

3. Individually collected insects (from 1, above), should be caged on healthy pines and allowed to feed for about one week. Cages should be removed and a spore suspension misted onto the trees or tree parts. If infection occurs, yet fails to develop on control trees, it will suggest that non-vector species provide infection courts for the fungus.

QUARANTINES

A. Other States and Countries

As word of the pitch canker infestation in California spreads, it should be anticipated that other states and countries will implement quarantines to protect their pine resources. The prudence of this action would be dictated by the wide host range of Fusarium subglutinans among the various species of pine. Australia and New Zealand, having imported Monterey pine germplasm from California in previous years, are likely to be particularly concerned.

B. Interior

Interior quarantines will be necessary to help prevent further spread of pitch canker in California. Articles to be regulated would include pine trees (particularly nursery stock), pine Christmas trees, pine tree parts (such as logs, cones, scion wood, and seeds), pine firewood, and pruning tools used on infected trees.

An intensive public awareness program would be necessary to help secure the cooperation of the general public. Voluntary compliance would be essential, as it would be virtually impossible to effectively implement such a quarantine otherwise.

C. Exterior

An exterior quarantine should be implemented to help prevent any future introduction of pitch canker from infested southeastern states.

POTENTIAL IMPACT OF PITCH CANKER ON CALIFORNIA

Based on our very limited knowledge of such critical factors as host range among western pine species, insect vectors, and environmental conditions favoring infection, it is difficult to predict what the potential impact of pitch canker might be. We do know that Monterey pine is highly susceptible to pitch canker. Infections were also found on Bishop and Aleppo pines. Recent inoculation studies by Dr. McCain indicate that Aleppo pine is, however, highly resistant.

Greenhouse inoculation studies indicate other California pine species are susceptible to pitch canker (see Appendix I). Although these tests employ potted seedlings and small trees, the relative susceptibility of the various pine species is useful data.

Insect vectors of the pathogen in California, if any, are unknown. Widespread tip dieback high in the crown suggests insect involvement in pitch canker dissemination. This involvement could consist merely of creating wounds which serve as infection sites for the pathogen, or it could also involve active transport of the pathogen by the insect(s).

Environmental conditions conducive to infection and dissemination are not well defined. The drought-heavy rain cycles in the Santa Cruz area from 1977 to 1983 may have placed additional stress on the trees, thereby enabling pitch canker to gain a strong foothold in the area.

It can be stated with reasonable certainty that pitch canker will not disappear if left unchecked. It will either remain at some roughly constant level or, more likely, it will become worse, spreading beyond the present infested area. Increased tree mortality could permit bark beetle populations to build to damaging levels, furthering their potential as vectors, or creating a serious problem even in the absence of increased pathogen spread.

In a worst-case scenario, pitch canker could spread up and down the coastal areas, damaging home and other ornamental pine plantings and the Christmas tree industry, eventually bridging, via Digger and Coulter pines, into the major forest areas of the state. This could result in untold damage to California's timber and recreational resources, not to mention those of our neighboring states and Canada. An estimate of the volume and value of California's major lumber-type pines is given in Appendix X.

In the meantime property owners, both public and private, will be faced with the problem of dead and dying trees. These trees will, for the most part, have to be removed to avoid their becoming eyesores, safety hazards (from falling branches), or fire hazards.

Valuable genetic resources, in the form of native stands of Monterey and other pines, are also threatened by this disease. These stands, which are an international resource, should be protected.

ACTION OPTIONS

Four levels of activity were considered: 1) Do nothing, 2) Containment, 3) Intensive disease control, and 4) Eradication. Each option will be discussed separately.

Option 1): Do nothing.

Arguments Pro: a) Pitch canker has already spread too widely to attempt to control it; b) the disease is cyclic in the southeastern U.S.--it may also be cyclic in California; c) California's unique environment may limit the disease to the central coastal area; and d) Monterey pine is not a commercial timber species in California.

Arguments Con: a) Although a substantial area is already infested, it represents a very small percentage of the total pine acreage in California; b) no evidence of disease subsidence has been seen to date--instead, pitch canker seems to be on the increase; c) pitch canker is found from Florida on the south to Virginia on the north to Texas on the west. It appears to be adapted to a diversity of climates. Also, other Fusarium spp. flourish throughout California; d) native stands of Monterey pine are now threatened. We need to preserve this valuable germplasm resource. Monterey pine is used extensively as an ornamental for landscaping. Limited information suggests that many western pines, including major timber species, are susceptible to pitch canker; e) Caltrans and Parks and Recreation are already pursuing an active

program of removing infected trees as part of their ongoing landscaping maintenance programs. Failure of other agencies to act would negate much of their effort; f) landowners will incur substantial expense with disease control/tree removal efforts.

Option 2): Containment.

This option is envisioned as a program to confine pitch canker to approximately the present infested area. Quarantines would be established to help prevent movement of the pathogen to new areas, and would include public information programs. A statewide pitch canker survey would be implemented.

Project survey and control activities would include "new" satellite infestations and the periphery of the infested area. They would have to continue indefinitely to be effective.

While this option would help to protect most of California's pines outside the generally infested area, pitch canker inoculum levels would probably continue to increase and, as the number of disease-stressed trees increases, so would populations of pine insects (insect vectors in California have not been identified as yet).

Option 3): Intensive disease control.

This option would include quarantines and a public information program to help prevent further movement of the pathogen. A statewide pitch canker survey would be implemented.

Project survey and control activities would not only be directed at satellite infestations and the periphery of the infested area, but would also operate within the infested area to reduce inoculum levels. Control activities would involve pruning, where only a few branches are infected, or removal, in the case of heavily infected pines. Obviously, the inoculum levels would be reduced; the degree of reduction would depend on the frequency and intensity of survey/control operations.

Option 4): Eradication.

This option would also include quarantines and a public information program to help prevent further movement of the pathogen. A statewide pitch canker survey would be implemented.

Intensive survey and control activities would be directed at all infestations. Control activities would include removal of all infected pines and, quite likely, the immediately adjacent pines as well. A program to control potential insect vectors would be employed.

RECOMMENDATIONS

The recommendations consist of two parts. The first part is an action recommendation. The second part is a recommendation addressing research needs.

1) Action Recommendation:

The Interagency Working Group recommends the following initial course of action:

A. Quarantines

Implement appropriate interior quarantines to regulate the movement of pine seeds, nursery stock, Christmas trees, firewood, and other pine tree parts from the infested areas to help prevent further dissemination of the pathogen. Implement an appropriate exterior quarantine to help prevent any future introduction of pitch canker from infested southeastern states.

B. Survey

Continue delimitation surveys in and around the current infestations. Implement a coordinated statewide survey of pines for the pitch canker disease.

C. Public Information

Implement a comprehensive public information/education program regarding pitch canker. The program should include information for residents on how to care for their pines to minimize the risk of infection, how to recognize and handle diseased trees, and steps they can take to help avoid further dissemination of the pathogen.

Utility companies, private tree service companies, and governmental agencies involved in tree pruning operations should be provided information on equipment sanitation procedures to avoid pathogen dissemination. Landscaping maintenance programs should be modified to minimize the risk of infection for pines.

Information should be provided on alternatives for pines in landscaping/ornamental uses within the infested areas.

D. Site Monitoring

Establish carefully defined sites within and on the periphery of the infested areas. Monitor these sites to determine what is happening with respect to pitch canker; is the disease becoming more or less severe, is there movement of the pathogen, what is the effect of the disease on the trees.

E. Satellite Infestations

Several small "satellite" infestations exist in Alameda, Monterey, San Mateo, and Santa Clara counties. These sites provide an opportunity to study the feasibility of various eradication procedures, should that approach prove necessary in the future. This study should be implemented as soon as possible to help prevent further spread of pitch canker at these sites.

F. Inoculum Reduction

Where feasible, inoculum levels should be reduced within the infested areas to slow the rate of pathogen dissemination. To this end, Parks and Recreation's

ongoing program to replace the planted Monterey pines at New Brighton State Beach with native oaks should be encouraged, as should Caltrans' landscaping maintenance Program which calls for the removal of dead or dying trees for both safety and aesthetic reasons.

G. Disposal of Diseased Material

Disposal of prunings and removed trees presents a problem in the infested area, as the landfills there have indicated that they do not have adequate space. Alternatives include burning (would require permits), chipping (small branches should be chipped and left on site), utilization after debarking (bark to be chipped, burned, or buried), or possible utilization for charcoal, chipboard, etc., with suitable safeguards.

H. Research

Implement a research program on the pathogen, host range, insect vectors, and environmental conditions affecting the disease.

I. Evaluation

The Interagency Working Group should reconvene after six months to evaluate the program, with a status report to be issued by the end of the year. Thereafter, the program should be evaluated on an annual basis.

2) Research Recommendation:

Much of the difficulty encountered in determining an appropriate response to the pitch canker infestation is due to lack of information about the disease, particularly with

respect to California conditions. The Group recommends that a strong, well-supported research program be implemented to develop information in the following areas:

A. Pathogen

1. Where, when, and under what conditions does it sporulate?
2. Are there alternate hosts or other survival mechanisms (e.g. will the fungus survive in pine firewood)?
3. How is the pathogen being disseminated in California--by vectors, wind/rain, cultural operations?
4. How long has the pathogen been present in California? Was it introduced, or could it have evolved here in association with Monterey (or other) pine?

B. Vector(s)

1. Which, if any, insects function as vectors in nature?
2. What is the life cycle of the vector(s), including critical periods and seasonal duration of vector activity?
3. What means can be used to control the vector(s)?
4. Is there any effective way to monitor vectors for presence of the pathogen, Fusarium subglutinans?
5. Are there other, non-vector insects that are of particular significance in the epidemiology of pitch canker in California?

C. Hosts

1. Which pines are hosts and what is their relative susceptibility?
2. Are there naturally infected hosts other than pine?
3. What is the rate of disease spread and build-up under various California conditions (monitor infection rate and disease spread in known trees over time)?
4. What are the "look-alike" diseases and disorders (e.g. gall rust, sequoia pitch moth)?
5. How can infected/exposed wood be safely utilized or disposed of?
6. Develop effective wound treatments for pruning or other damage.
7. Develop effective seed treatments to prevent seed transmission of the fungus.

D. Environment

1. What conditions favor infection?
2. At what time(s) of the year are trees infected?
3. What is the latent period (period from infection to symptom expression) at various times of the year?

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3) Dwinell, L.D., J.B. Barrows-Broaddus, and E.G. Kuhlman. 1985. Pitch canker: a disease complex of southern pines. Plant Dis. 69:270-276.

4) Blakeslee, G.M., L.D. Dwinell, and R.L. Anderson. 1980. Pitch canker of southern pines: identification and management considerations. USDA For. Serv. Forestry Report SA-FR-11.

APPENDIX I

Confirmed Hosts of the Pitch Canker Fungus

Fusarium subglutinans (Wollenw. & Reink.) Nelson, Toussoun & Marasas

Pinus species	Common Name of Pine
elliottii var. eliottii	slash
elliottii var. densa	Florida slash
virginiana	Virginia
echinata	shortleaf
strobus	Eastern white
palustris	longleaf
pungens	Table-mountain
ridgida	pitch
occidentalis (Hati)	?
radiata	Monterey
sylvestris	Scotch
nigra	Austrian
clausa	sand
serotina	pond
muricata*	bishop
halepensis* (from rust galls only)	Aleppo
mugo**	mugo

*California reports; not yet in literature

**G.M. Blakeslee, personal communication

Greenhouse U.C. Berkeley 1987 (infected by artificial inoculation)

<u>Susceptible</u>	
sabiniana	digger
eldarica	Eldarica
coulteri	Coulter
radiata x attenuata	--
ponderosa	ponderosa
pinea	Italian stone
<u>Not susceptible</u>	
halepensis	Aleppo

APPENDIX II

Santa Cruz Area Survey (February 1987)

Summary by Sectors

Sector	Estimated Number of Infected Trees	Estimated Number of Total Trees
1. Natural Bridges	3	1,000
2. U.C. Santa Cruz	0	1,000
3. South Santa Cruz	30	500
4. North Santa Cruz	70	500
De Laveaga Park	200	2,000
5. West Soquel		
Charminade School	100+	1,000+
West Soquel	120	900
Santa Cruz Gardens School	100+	100+
Rodeo Mobile Estates	60+	60+
Soquel High School	?	75
6. East Soquel	350	2,500
7. Capitola	350	2,900
Mobile Home Park between 44th & 46th at 1745-1785	400	1,000
8. Twin Lakes (south Soquel)	170	800
9. Rio del Mar	45	2,000
10. La Selva Beach	0	600
11. Aptos	77	6,000
12. Freedom	4	580
13. North Watsonville	2	536

G & G Auto Wreckers	80	100
14. South Watsonville	0	36
15. Pajaro	0	23
Granite Construction Co.	5	23
16. Pajaro County Club (estimated by manager)	74	322
TOTALS	2,240	24,555

Estimated infection rate: 9.1%

Survey conducted February 9-27 by D. Adams and T. Tidwell.

APPENDIX III

Pitch canker survey in Santa Cruz County by personnel from the Dutch Elm Disease Project, California Department of Forestry.

Pitch Canker Survey in Santa Cruz County, November 1986

Stephen R. Scott[1/]

Introduction

Symptoms of the pitch canker fungus, *Fusarium moniliforme* var. *subglutinans*, were first detected in the Santa Cruz area during the summer of 1986. The fungus was later isolated in samples from Monterey, Bishop, and Aleppo pines. In order to determine the extent and severity of the infestation, a delimitation survey was initiated. Cursory inspection of the area showed that affected pines were in an area generally bound on the west by the San Lorenzo River, on the north along and immediately north of State Highway 1, and on the east by New Brighton State Beach. The infestation appeared to extend south to the coast. The predominant pine species in this area, all non-native, is Monterey pine (*Pinus radiata*).

Materials and Methods

The delimitation survey would commence within known areas of pitch canker infestation and spread west, north, and east-southeast of this area. Four personnel from the Dutch Elm Disease (DED) Project, working in two-person crews, surveyed the western and eastern halves of the work area respectively. Training in symptomology (on-site), pine identification, and recognition of other pine pest problems were given to the surveyors prior to the start of the field work.

1/ California Department of Forestry, Dutch Elm Disease Project, 4000 Middlefield Road, Palo Alto, CA 94303

Since the host list is incomplete for the pitch canker, survey crews inspected all species of pine encountered. Binoculars were used, when necessary, to detect the color change at the branch tips and associated pitch exudation. Loppers and pole pruners were employed to sample branches for evidence of pitch-saturated wood. Samples were taken from the cankerous/healthy wood interface, placed in plastic bags, and kept in a cooler. A Pest and Damage Record (PDR) was written for each tree sampled showing external and internal symptoms. A tag with the PDR number and date sampled was affixed to the sampled tree. Sampled branches were cut back to healthy whorls or the trunk. Sampling tools were cleaned with rubbing alcohol and disinfected with Lysol after each sampling. Samples were submitted to the DED Project Laboratory in Sonoma for culture. A suspect card was filled out for each tree needing sampling with specialized equipment (i.e. aerial lift truck) or permission to sample from the property owner.

Results and Discussion

Two crews surveyed and sampled pines in Santa Cruz County and extreme southern San Mateo County for nine days between November 7 and 24, 1986. The area surveyed was as follows: Ano Nuevo State Reserve in San Mateo County, the Santa Cruz County coast south and east to Sunset State Beach; inland to Watsonville in the southeast; then northwest to Aptos and Soquel; and north to Scotts Valley, Mt. Hermon and Felton.

Only Monterey pines were observed with pitch canker symptoms. No symptoms were seen in the native stand of Monterey pine at Ano Nuevo.

The western limit of pitch canker appears to run from the student housing area on the University of California-Santa Cruz campus south along Western Drive to Swift Street just east of Natural Bridges State Beach (see Fig. 1). Laboratory confirmations through December 2, 1986 included one Monterey pine on Swift Street and another on Ortalon Circle just west of Harvey West Municipal Park. There are numerous suspects and an additional two confirmed pitch canker trees in the city of Santa Cruz west of the San Lorenzo River. The many pines at Natural Bridges were not exhibiting symptoms at the time of the survey.

The northern limits of pitch canker appear to be within 1 to 2 miles north of Highway 1. Beginning at De Laveaga Park and Golf Course, symptomatic trees extend east to Santa Cruz Gardens Park, Rodeo Gulch Road near Hidden Valley Road, to Cabrillo College just north of Soquel Drive. The most northern confirmed pitch canker tree is 1.25 miles north of Highway 1 just east of Soquel-San Jose Road. No symptomatic trees were found north of the Santa Cruz city limits except along Highway 17 just north of Highway 1.

The present eastern limit appears to be near State Park Drive and Highway 1 where a Monterey pine was positively confirmed for pitch canker. Several suspect pines southeast of this area exhibited no pitch canker symptoms upon closer examination.

Within the aforementioned limits, there are numerous suspects from the city of Santa Cruz on the west to Aptos on the east. Areas with concentrations of symptomatic pines include: San Lorenzo Park north to Highway 1 and De Laveaga Park and Golf Course in Santa Cruz; the Corcoran Lagoon area in Live Oak; the Santa Cruz Gardens Park area, Soquel Drive and nearby areas (various) in Soquel; the entire eastern two-thirds of the city of Capitola; the Cabrillo College area; New Brighton State

Beach; Highway 1 from about High Street in Santa Cruz to State Park Drive in Aptos; and the Highway 17-Highway 1 interchange area.

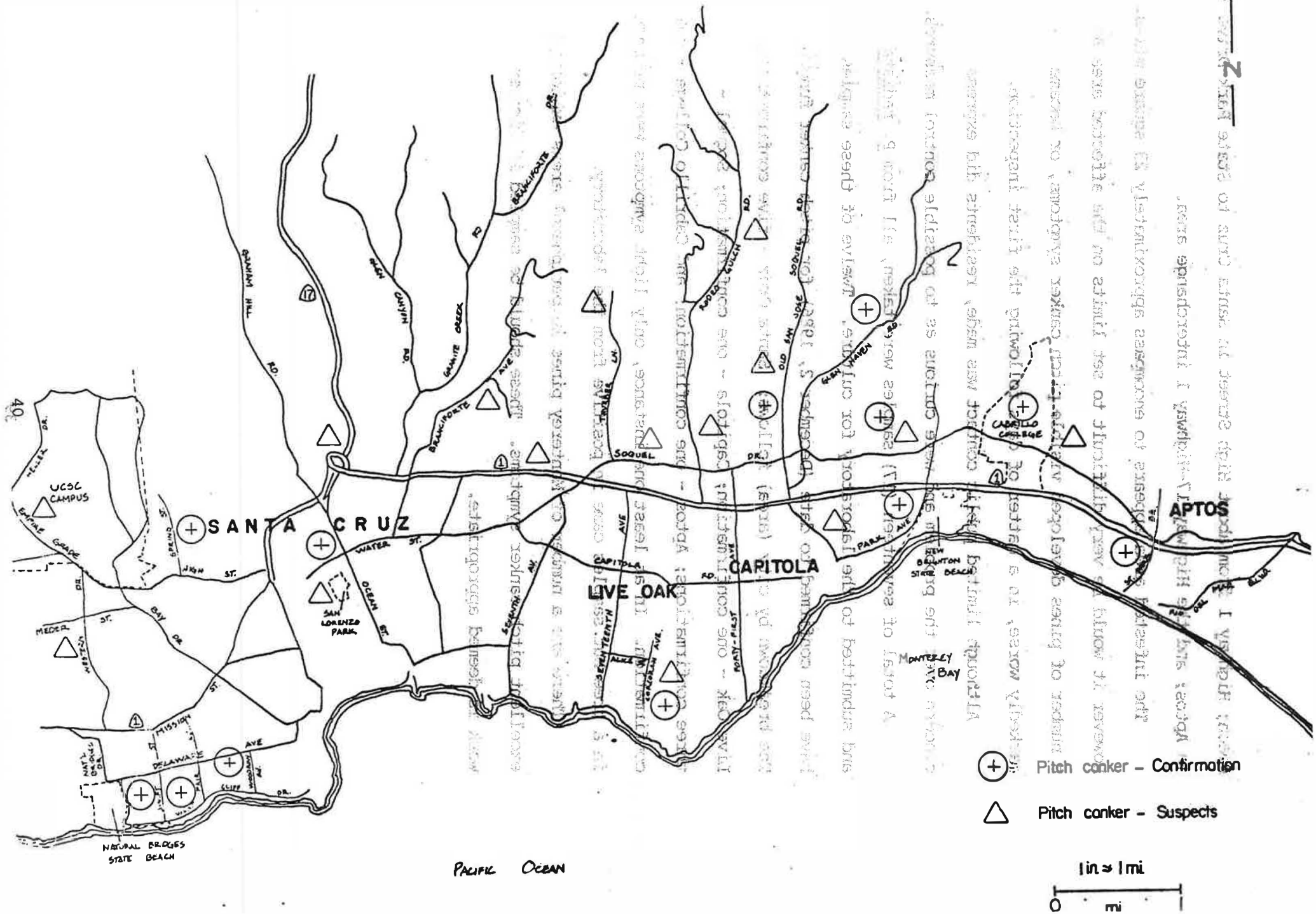
The infested area appears to encompass approximately 23 square miles. However it would be very difficult to set limits on the affected area as a number of pines developed visible pitch canker symptoms, or became markedly worse, in a matter of days following the first inspection.

Although limited public contact was made, residents did express concern over the problem and were curious as to possible control measures.

A total of seventeen (17) samples were taken, all from P. radiata, and submitted to the laboratory for culture. Twelve of these samples have been confirmed to date (December 2, 1986) for pitch canker fungus. The breakdown by city (area) follows: Santa Cruz - five confirmations; Live Oak - one confirmation; Capitola - one confirmation; Soquel - three confirmations; Aptos - one confirmation; and Cabrillo College - one confirmation. In at least one instance, only light symptoms were present in a tree but samples came in positive from the laboratory.

There are a number of Monterey pines in peripheral areas exhibiting excellent pitch canker symptoms. These should be sampled if further work is deemed appropriate.

Figure 1. Pitch canker affected area, Santa Cruz County (November 1986).



APPENDIX IV

Pitch canker survey in northern California coastal counties by Jack Marshall, California Department of Forestry.

State of California The Resources Agency

Memorandum

To : Richard J. Ernest, Chief, Region I
Attention: Ray Utterback, Resource Manager

Date : January 28, 1987

Telephone: ATSS ( )
( )

From : Department of Forestry and Fire Protection
Jack Marshall, Forest Pest Control Specialist

Subject: 4800 PEST CONTROL
4810 Pitch Canker Survey

Pitch canker, a plant disease whose U. S. occurrence was formerly limited to the southeast on slash, loblolly, and other southern pines, was identified on Monterey, Bishop, and allepo pines in the Santa Cruz, California, vicinity in 1986. Identifications of the pitch canker fungus, Fusarium moniliforme Sheld. var. subglutinans Wollenw. & Reink., were made by U. C. Extension Plant Pathologist Dr. Art McCain.

In October, 1986, a meeting of interested plant pathologists, entomologists, and foresters was held in Sacramento to discuss the implications of pitch canker in California. Those in attendance agreed we should try to delineate the occurrence of pitch canker before considering any suppression or eradication efforts.

The following documents routes I have surveyed, areas from which the samples were taken, and identification status of samples.

Routes Surveyed:

I looked for pitch canker symptoms on all pine species while driving the following routes or, in the case of Highway 1, major coastal sideroads which extended into areas inhabited by pines. The routes surveyed were:

-- Highway 20 from Willits to Fort Bragg
-- Highway 116 from Bodega Bay to Santa Rosa
-- Highway 101 from Eureka to Ukiah
-- Highway 1 from Leggett to Bodega Bay and from Santa Cruz to Half Moon Bay (No samples were submitted from the immediate Santa Cruz area wherein pitch canker has already been confirmed.)

Off-road from Highway 1:
Russian Gulch State Park
Point Cabrillo
Manchester State Beach (Kinney Road)
Stoneboro Road (south of Manchester)
Point Arena (beach access)
Gualala Regional Park
Sea Ranch Golf Course
Sea Ranch (Whalebone Reach area)
Salt Point State Park (Fisk Mill Cove)
Stump Beach

Host and Location of Submitted Samples:

Numerous stops were made to determine cause of branch "flagging" predominately on Monterey, Bishop, and shore pines. Over 90% of the flagged branches was due to formation of branch galls caused by the western gall rust fungus, Endocronartium harknessii (Moore) Hiratsuka. Branch samples were only submitted when resinous cankered areas were noted, or when I suspected pitch canker could possibly be working in association with galls formed near cone attachment (frequent sites for pitch canker origination).

Sample #	Host	Location
1	Bishop pine	5 miles south of Point Arena on Highway 1
2	Bishop pine	7 miles south of Point Arena on Highway 1
3	Bishop pine	9 miles south of Point Arena on Highway 1
4	Monterey pine	Intersection of Highway 101 and Gobbi Street, Ukiah
5	Bishop pine	Sea Ranch (Whalebone Reach), Sonoma County, Highway 1
6	Bishop pine	Sea Ranch (Whalebone Reach), Sonoma County, Highway 1

Status of Sample Identifications:

All samples were taken, in fresh condition, to the Dutch Elm Disease Laboratory in Sonoma for isolation and identification of possible plant pathogens. Samples 1-4 were submitted on January 7, and samples 5-6 were submitted January 22. To date no responses have been returned from the lab. Once isolations/identifications are final, I'll send you that information.

ROBERT D. DAY
Ranger-in-Charge

by Jack P. Marshall

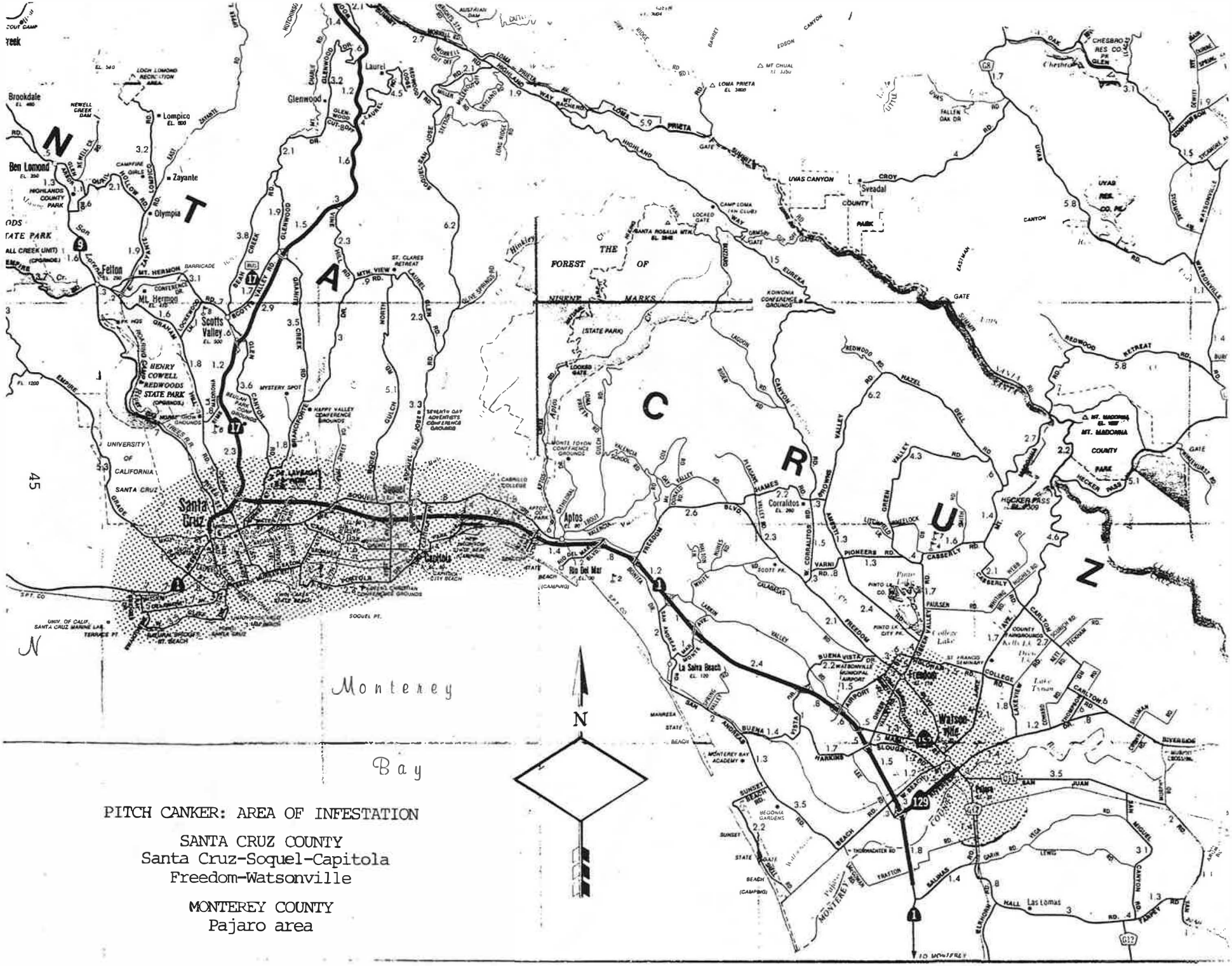
JACK MARSHALL
Forest Pest Control Specialist

JM:dd

cc: Dave Burns
Bruce Hagen
Dave Adams

APPENDIX V

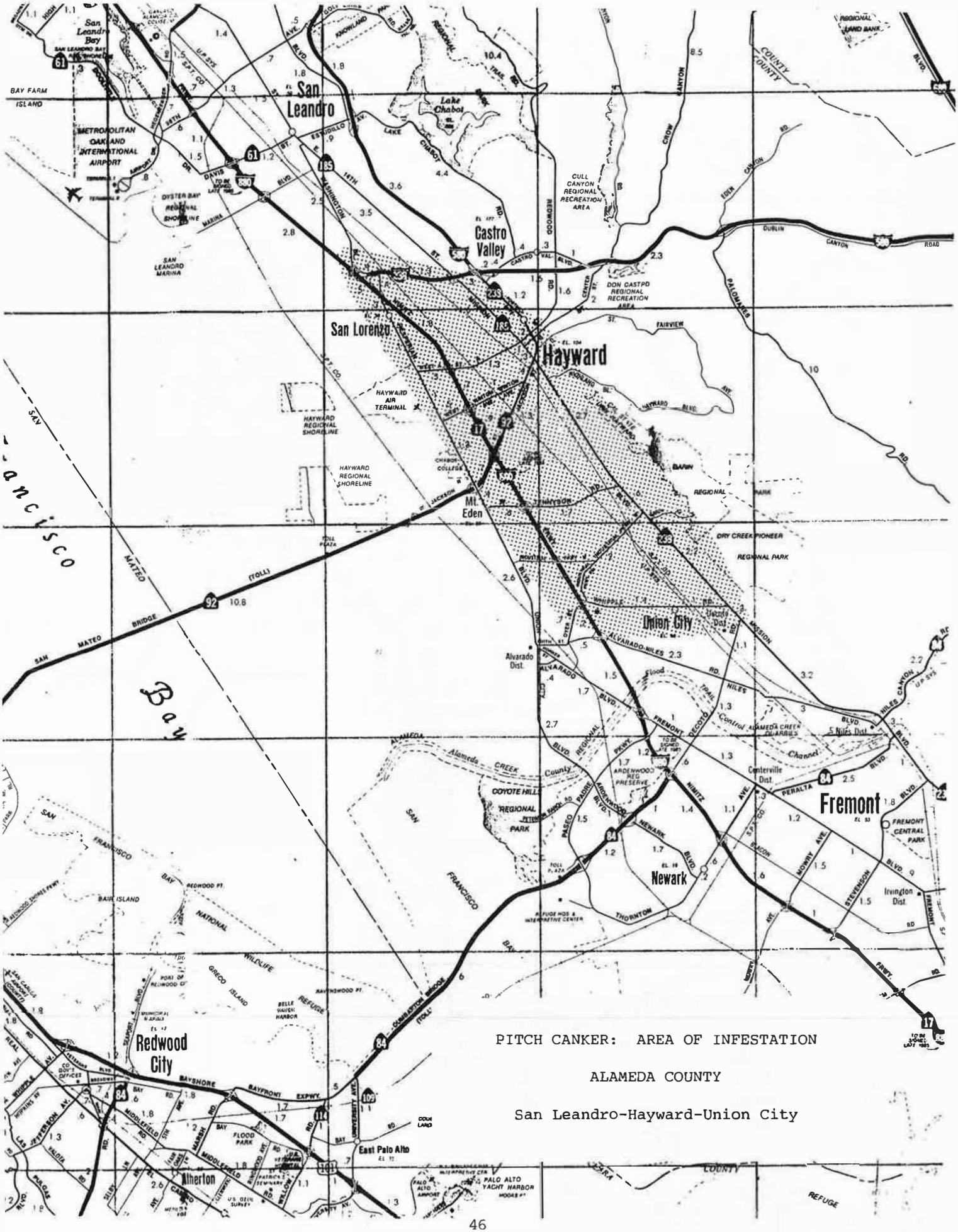
Maps of infested areas in Santa Cruz, Alameda, Monterey, San Mateo, and Santa Clara counties.



PITCH CANKER: AREA OF INFESTATION

SANTA CRUZ COUNTY
Santa Cruz-Soquel-Capitola
Freedom-Watsonville

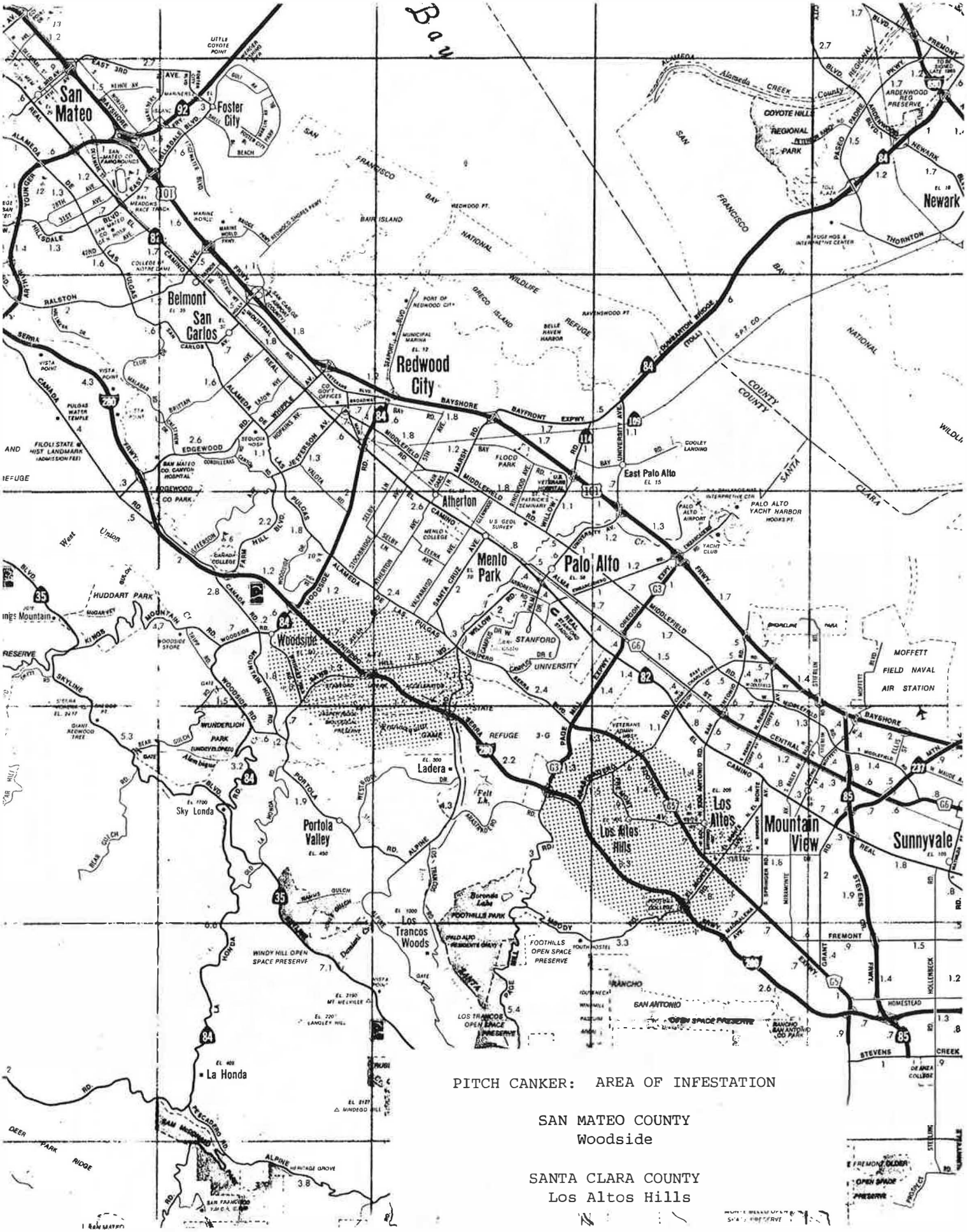
MONTEREY COUNTY
Pajaro area



PITCH CANKER: AREA OF INFESTATION

ALAMEDA COUNTY

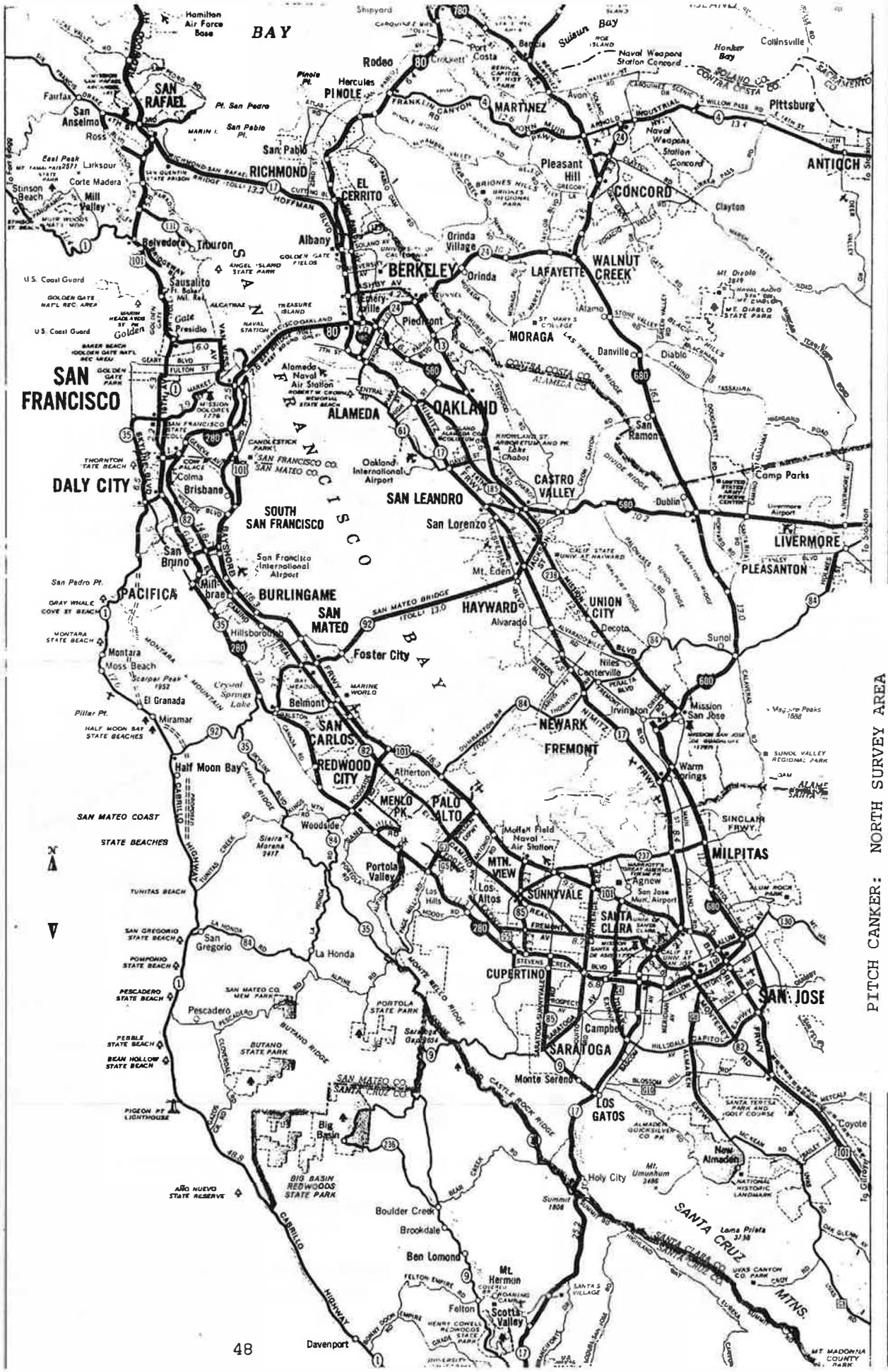
San Leandro-Hayward-Union City



PITCH CANKER: AREA OF INFESTATION

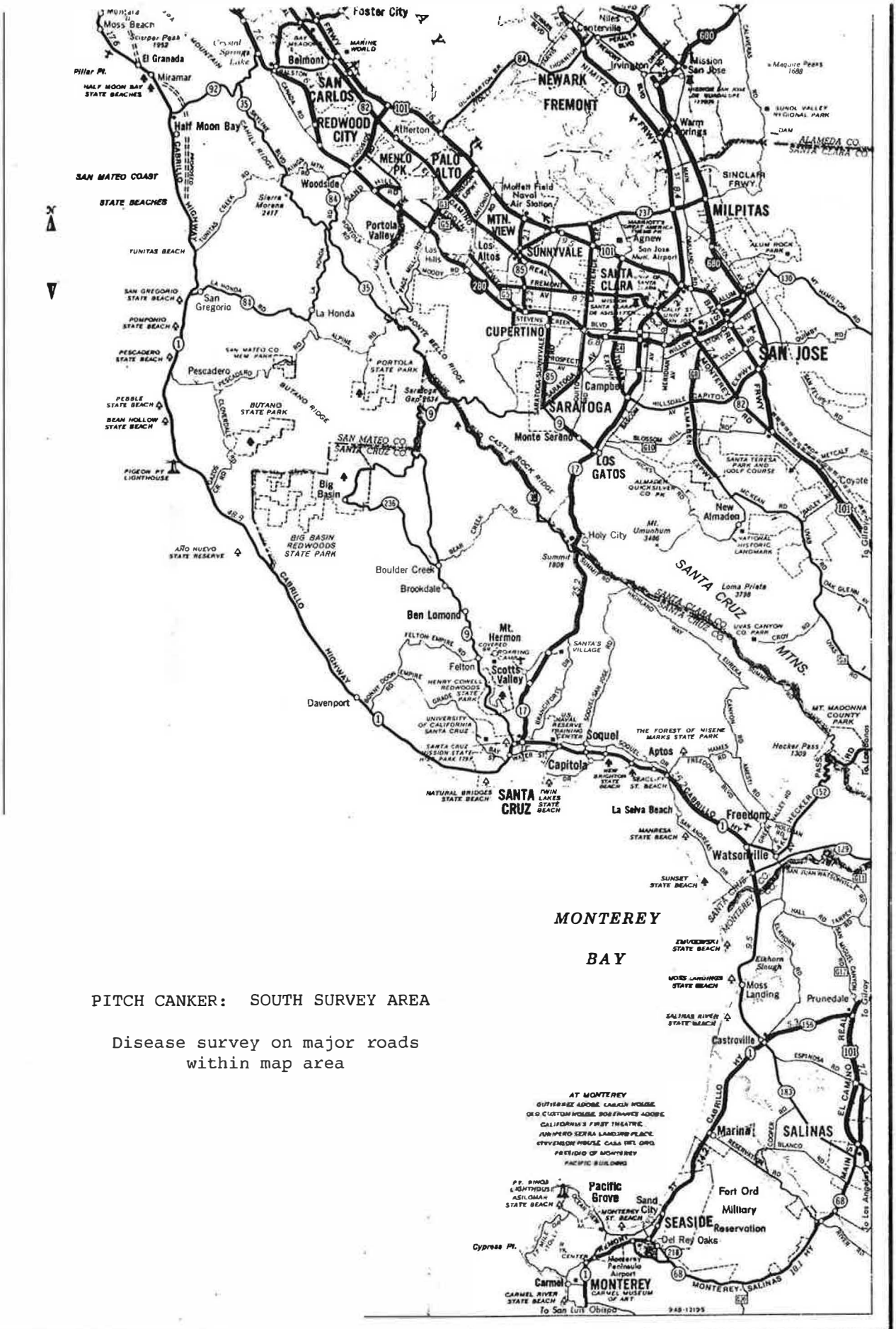
SAN MATEO COUNTY
Woodside

SANTA CLARA COUNTY
Los Altos Hills



PITCH CANKER: NORTH SURVEY AREA

Disease survey on major roads within map area



PITCH CANKER: SOUTH SURVEY AREA

Disease survey on major roads within map area

APPENDIX VI

Pitch canker sampling guidelines, laboratory identification procedure, and sample summaries.

COLLECTING AND SUBMITTING SAMPLES FOR LABORATORY DIAGNOSIS

GUIDELINES FOR PITCH CANKER SAMPLES
Fusarium moniliforme var. *subglutinans*

WOOD SAMPLE SPECIFICATIONS

1. STERILIZE TOOLS: Spray tools before and after each cut with Lysol aerosol disinfectant. Remove any pitch with rubbing alcohol.

2. INCLUDE BOTH CANKER AND ADJACENT HEALTHY WOOD

3. LEAVE BARK INTACT

4. LENGTH - 8 INCHES

5. KEEP SAMPLES CLEAN

6. PACKAGE SAMPLES: Place all samples from a single tree in a plastic bag.

7. RECORDS: For each tree, submit one Pest and Damage Record (Form 65 020) or Forest Pest Detection Report (Form R5-5200-33). Staple record to outside of plastic bag.

8. KEEP SAMPLES COOL: Refrigerate samples as soon as possible and ship quickly.

SEND ALL SAMPLES COLLECTED IN CALIFORNIA TO:

STATE OF CALIFORNIA
DEPARTMENT OF FORESTRY & FIRE PROTECTION
DUTCH ELM DISEASE LABORATORY
865 WEST NAPA ST., SUITE D
SONOMA, CA 95476
(707) 938-8585

LABORATORY RESULTS

Laboratory results will be mailed usually within three weeks of sample plating.

Thank you for your cooperation.

Loretta Smith
Sampling Supervisor

Leslie Markham
Lab Technician

1/30/87

Laboratory Culture of the Pitch Canker Fungus, *Fusarium moniliforme* var. *subglutinans*

Dr. Alleah B. Haley[1/]

Small pieces of pitch-soaked wood, or wood from the canker margin, are plated on acid potato dextrose agar (PDA) and pea straw agar in petri dishes. The cultures are incubated at room temperature, with supplemental fluorescent light for approximately four hours per day, for seven to fourteen days. Then the cultures are examined for diagnostic features of *Fusarium moniliforme* var. *subglutinans*. These are: presence of typical colonies on PDA and pea straw agar, diffusible violet pigment, all using the dissecting microscope; and with the compound microscope at 400X: sympodial branching of the conidiophore, abundant typical microconidia produced in false heads on simple- and polyphialides, typical beaked macroconidia with a foot cell (when present), and absence of chlamydospores. Key diagnostic characters include typical colonies, sympodial branching, and polyphialides.

Twelve (12) samples have been confirmed for pitch canker fungus through December 2, 1986. Pathogenicity tests are being conducted.

1/ California Department of Forestry, Dutch Elm Disease Project, 865 West Napa Street, Sonoma, CA 95476

CDF DUTCH ELM DISEASE LABORATORY
Samples Received for Pitch Canker Diagnosis
November 14, 1986 - February 27, 1987

COUNTY SUMMARY

County	Number of Samples Received	Positive for Pitch Canker	Negative for Pitch Canker	Still in Culture
Alameda	13	7	4	2
Contra Costa	1	-	-	1
Fresno	1	-	-	1
Humboldt	6	0	6	-
Mendocino	6	0	6	-
Monterey	5	3	1	1
San Francisco	1	0	1	-
San Mateo	9	0	6	3
Santa Clara	15	0	6	9
Santa Cruz	25	20	5	-
Sonoma	2	0	2	-
TOTAL	84	30	37	17

CDF DUTCH ELM DISEASE LABORATORY
Samples Received for Pitch Canker Diagnosis
November 14, 1986 - February 27, 1987

BREAKDOWN BY CITY

County	City	Number of Samples Received	Positive for Pitch Canker	Negative for Pitch Canker	Still in Culture
Alameda	Castro Valley	2	-	-	2
	Hayward	3	3	0	-
	Oakland	3	0	3	-
	San Leandro	3	2	1	-
	Union City	2	2	0	-
Contra Costa	Danville	1	-	-	1
Fresno	Orange Cove	1	-	-	1
Humboldt	Eureka	2	0	2	-
	Loleta	4	0	4	-
Mendocino	Gualala	1	0	1	-
	Point Arena	2	0	2	-
	Ukiah	3	0	3	-
Monterey	Moss Landing	1	0	1	-
	Pajaro	3	3	0	-
	Prunedale	1	-	-	1
San Francisco	San Francisco	1	0	1	-
San Mateo	Ano Nuevo Reserve	2	0	2	-
	Hillsborough	1	-	-	1
	Ladera	1	0	1	-
	Menlo Park	4	-	2	2
	San Mateo	1	0	1	-
Santa Clara	Coyote	2	-	-	2
	Los Altos	1	-	-	1
	Los Altos Hills	4	-	-	4
	Mountain View	4	-	4	-
	Palo Alto	4	0	2	2
Santa Cruz	Aptos	4	4	0	-
	Capitola	2	2	0	-
	Live Oak	1	1	0	-
	Santa Cruz	8	7	1	-
	Soquel	7	6	1	-
	Unicorp. No. Co.	3	0	3	-
Sonoma	Sea Ranch	2	0	2	-

CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE
Plant Pathology Laboratory

Samples received for pitch canker diagnosis
November 1, 1986 - March 4, 1987

COUNTY	CITY	COLLECT	RESULTS	PDR#
ALAMEDA	HAYWARD	10/31/86	POSITIVE	763101
MONTEREY	SOLEDAD	12/04/86	NEGATIVE	775711
MONTEREY	PAJARO	12/23/87	POSITIVE	640099
VENTURA	VENTURA	01/12/87	NEGATIVE	652390
SAN MATEO	WOODSIDE	01/21/87	NEGATIVE	665776
SAN JOAQUIN	---	01/22/87	NEGATIVE	749917
SAN MATEO	MENLO PARK	01/21/87	POSITIVE	665772
SANTA CLARA	LOS ALTOS	01/30/87	POSITIVE	761074
SANTA CRUZ	SANTA CRUZ	02/11/87	POSITIVE	740194
SANTA CRUZ	SANTA CRUZ	02/11/87	POSITIVE	740023
MENDOCINO	UKIAH	02/18/87	PENDING	668833
SANTA CRUZ	APTOS	02/25/87	PENDING	739968
SANTA CRUZ	WATSONVILLE	02/25/87	PENDING	740200
SANTA CRUZ	WATSONVILLE	02/25/87	PENDING	740199
SANTA CRUZ	RIO DEL MAR	02/25/87	PENDING	740198
SANTA CLARA	SANTA CLARA	02/24/87	PENDING	668136
SANTA CRUZ	WATSONVILLE	02/24/87	PENDING	740196

APPENDIX VII

Letters from Parks and Recreation, Caltrans, and U.S.D.A. Forest Service concerning the current impact of pitch canker on their agencies.

STATE OF CALIFORNIA—THE RESOURCES AGENCY GEORGE DEUKMEJIAN, *Governor*

DEPARTMENT OF PARKS AND RECREATION
Central Coast Region
2211 Garden Road
Monterey, California 93940
(408) 649-2840

February 17, 1987

Dr. Conrad J. Krass
Department of Food and Agriculture
Division of Plant Industry
Analysis and Identification
1220 N Street
Sacramento, California 95814

Dear Dr. Krass:

In response to your request for information, I am forwarding Dr. Jason Greenlee's comments to you, as he has temporarily returned to the field.

We estimate, from a field search of New Brighton State Beach, that more than 250 trees are infected with pitch canker. When actual operations on the disease commence, the figure will probably be closer to 400 trees that need treatment. At Natural Bridges State Beach, less than half a dozen trees show signs of infection.

We plan to cut the trees and process them either on the site or very close to the site, provided the committee on which Dr. Greenlee sits concurs. Several alternative locations for processing are being investigated. Processing will probably include delimbing and chipping of limbs and tops, debarking and burning of bark, bucking and splitting of the stem and sale of firewood. At this point, we do not plan to move any of the materials or products from the vicinity of the park, due to the risk of carrying the disease or bark beetles to a presently uninfested site. We plan to replant with 5-gallon, or larger, oak trees. We are trying to coordinate with the needs and resources of Caltrans in this effort.

We foresee the following problems at this time:

1. We have not budgeted for the expenses that we foresee, which include rental of debarking equipment and operators, possible rental of a mechanism to burn waste without excessive smoke emission, transportation costs and possible cost of tree cutting and processing contract.

2. We do not have the manpower to cut and process the trees. We hope to be able to use California Youth Authority crews through the California Department of Forestry, but with the constraints on and competition for their time, this is not a certainty.

3. We will need to chip and burn tops and limbs. Unless we can transport these to someone who can use them or who can accept them at a landfill, we will need to dispose of them by burning. Obtaining a site and a permit to do this may be a problem.

4. The processing operation will be noisy and smoky. We can anticipate problems locating a suitable site in this urban area.

5. Provisions must be made for the potentially hazardous falling of trees; i.e., barricades, traffic control, etc.

6. We foresee major public information needs.

Please contact me at (408) 649-2859 if you have further questions.

Sincerely,

Richard E. Felty
Regional Director

STATE OF CALIFORNIA—BUSINESS, TRANSPORTATION AND HOUSING AGENCY GEORGE DEUKMEJIAN, *Governor*

DEPARTMENT OF TRANSPORTATION
BOX 7310
SAN FRANCISCO, CA 94120
(415) 923-4444

February 19, 1987

404.23

Dr. Conrad Krass
California Department of
Food and Agriculture
1220 N Street
Sacramento, CA 94271-0001

Dear Dr. Krass:

The following is the information you requested from Caltrans:

1. The area of Highway 1 around Santa Cruz within State highway right of way. 1,200-1,300 trees that need removal.

2. 200-300 trees that are showing symptoms but could possibly be trimmed out and saved.

3. Some questions remain as to the possibility that Caltrans may need a permit to remove any tree on the ocean side of Highway 1 when the tree is 40" in diameter or larger.

4. If burning is decided upon, the Air Pollution Control Group contact, Mr. Jim Hansen (408) 443-1135, says burning will be allowed with a permit.

5. Caltrans highly recommends seedlings as they have proven to be the most productive. The recommended plant replacement is to be Sequoia Sempervirons or Pseudotsuga Menziesii. If funding is available, a larger plant size may become a possibility. However, Caltrans does have a policy restricting replanting.

UNION LABEL

If we can be of any assistance, please advise. We will be looking forward for your recommendations in the very near future.

Sincerely yours,

BURCH C. BACHTOLD
District Director

By Robert Burkett
for THOMAS J. WALSH, Chief
Highway Maintenance

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
PACIFIC SOUTHWEST REGION
REGIONAL OFFICE
630 SANSOME STREET
SAN FRANCISCO, CA 94111

REPLY TO: 3400

DATE: February 23, 1987

Dr. Conrad Krass
California Department of Food and Agriculture
1220 "N" Street
Sacramento, CA 95814

Dear Dr. Krass:

I would like to summarize Forest Pest Management's position concerning the pitch canker disease situation now in the central coastal area of California. This disease is a serious problem of planted pines in the South (especially Florida, Georgia, and South Carolina) and certainly interferes with the management of pines. In California, Monterey pine has already been infected in four counties and all evidence suggests a potential to cause significant damage to several other forest and ornamental pines in much of the State. We simply do not know the limits to this disease.

In pest management we prefer to be proactive and prevent problems rather than be reactive and have to suppress them. In the case of pitch canker, although there is much we do not know about the causal fungus, it seems practical and feasible to eliminate the disease now before the infestations become larger. All alternatives to eradication would allow this introduced pathogen to become established and, therefore, present a continuous management problem.

The Forest Service land nearest to the existing area of infestation is over 40 miles away (Monterey Ranger District, Los Padres National Forest) and consists primarily of the Ventana Wilderness. Still, pitch canker may threaten National Forest land and it is our responsibility to help prevent further spread of this disease. Personnel from the Los Padres Forest will be trained in pitch canker recognition and management.

This disease situation appears to meet the criteria for possible Federal funding support. There are no suppression dollars at our Regional Office level and requests would have to be made to the Washington Office. Approval of such requests depend greatly on the economic efficiency and biological effectiveness of the proposed treatment. Keep in mind that any suppression projects for pitch canker sent to Washington would have to compete with some very serious, widespread, and high national priority pest outbreaks.

The Forest Service supports and encourages an aggressive approach in dealing with pitch canker. We will continue to participate in any planning activities, but our future involvement depends greatly on what control actions are recommended by your committee.

Sincerely,

JOHN NEISESS
FPM Group Leader
State and Private Forestry

APPENDIX VIII

Pruning versus Tree Removal

The use of pruning (in selected cases) as a part of the intensive management program for pitch canker will be, without doubt, a controversial issue. There are situations, however, where its use is warranted.

Some of the situations envisioned are: 1) trees with only a few cankers on small branches, particularly if the tree is somewhat isolated from other pines (cost-effective to prune, less chance of additional infections); 2) trees with only a few small branch cankers, particularly if surrounded by heavily-infected trees (the tree may be highly resistant to pitch canker and serve as a useful source of germplasm); 3) lightly infected trees in high-value situations, such as landscape specimens.

It must be recognized that this type of pruning is normally not a one-time affair. Latent infections (infections not yet expressing symptoms) may exist, thereby necessitating follow-up visits and additional pruning.

The act of pruning creates wounds which are susceptible to infection. These wounds would have to be treated to prevent further infection. Pruning equipment would have to be disinfected after use to avoid further pathogen dissemination.

Nonetheless, pruning can be a cost-effective approach for selected lightly-infected trees, particularly those in high-value situations. It will also prove more palatable to environmental groups and the general public.

There are many cases, however, where pruning is not feasible and tree removal is appropriate. Heavily infected trees should be removed; pruning of all cankers would "butcher" the tree, as well as prove economically prohibitive. Heavily infected trees also are likely to contain many latent infections and would serve as sources of inoculum for pathogen dissemination.

Trees with bole (trunk) cankers should also be removed. These cankers continue to enlarge, eventually girdling the tree, and serve as prime inoculum sources.

Low-value trees, or those situated in hard-to-reach locations, should also be removed. Removal, obviously, is a one time operation; no further inspection is required.

APPENDIX IX

Pines Grown in California

Pinus albicaulis, Whitebark Pine
Pinus aristata, Bristlecone Pine, Hickory Pine
Pinus armandii, Armand David's Pine
Pinus attenuata, Knobcone Pine
Pinus x attenuradiata
Pinus ayacahuite, Mexican White Pine
Pinus banksiana, Jack Pine
Pinus brutia, Brutia Pine
Pinus bungeana, Lacebark Pine
Pinus canariensis, Canary Island Pine
Pinus caribaea, Slash Pine
Pinus cembra, Swiss Stone Pine
Pinus cembroides, Mexican Stone Pine
Pinus contorta, Shore Pine, Beach Pine
Pinus contorta var. bolanderi, Dwarf Beach Pine
Pinus coulteri, Bigcone Pine, Coulter Pine
Pinus densiflora, Japanese Red Pine
Pinus densiflora 'Pendula', Weeping Japanese Red Pine
Pinus densiflora 'Umbraculifera', Tanyosho, Japanese Table Pine, Japanese Umbrella Pine, Tanyosho Pine
Pinus echinata, Shortleaf Pine
Pinus edulis, Nut Pine, Pinyon Pine, Colorado Pinyon Pine, Two-Needled Pinyon Pine
Pinus eldarica, Eldarica Pine
Pinus flexilis, Limber Pine
Pinus halepensis, Jerusalem Pine, Aleppo Pine
Pinus insularis, Benguet Pine, Luzon Pine
Pinus jeffreyi, Jeffrey Pine
Pinus lambertiana, Sugar Pine
Pinus longaeva, Great Basin Bristlecone Pine, Intermountain Bristlecone Pine, Bristlecone Pine
Pinus monophylla, Pinyon pine, One-needled Pinyon Pine, Nut Pine
Pinus montezumae, Montezuma Pine
Pinus monticola, Western White Pine
Pinus mugo, Mugo Pine, Dwarf Mugo Pine, Swiss Mountain Pine, Mountain Pine
Pinus mugo var. pumilio, Shrubby Swiss Mountain Pine
Pinus muricata, Bishop Pine, Santa Cruz Island Pine
Pinus murrayana, Lodgepole Pine, Tamarack Pine
Pinus nigra, Black Pine, Austrian Pine, Austrian Black Pine
Pinus nigra subsp. laricio, Corsican Pine
Pinus palustris, Longleaf Pine, Georgia Pine, Southern Yellow Pine
Pinus parviflora, Japanese Five-Needled Pine, Japanese White Pine
Pinus patula, Mexican Pine, Jelecote Pine
Pinus pinaster, Maritime Pine, Cluster Pine
Pinus pinea, Italian Stone Pine, Umbrella Pine
Pinus ponderosa, Western Yellow Pine, Ponderosa Pine
Pinus ponderosa var. scopulorum, Rocky Mountain Yellow Pine

Pinus pseudostrobus
Pinus pumila, Dwarf Stone Pine, Dwarf Siberian Pine
Pinus pungens, Table Mountain Pine
Pinus quadrifolia, Four-Needled Pinyon Pine, Parry Pinyon Pine
Pinus radiata, Monterey Pine
Pinus radiata 'Eldorado'
Pinus resinosa, Red Pine
Pinus roxburghii, Chir Pine
Pinus sabiniana, Digger Pine
Pinus strobiformis, Mexican White Pine
Pinus strobus, Eastern White Pine
Pinus strobus 'Brevifolia'
Pinus strobus 'Densa'
Pinus strobus 'Fastigiata'
Pinus strobus 'Minima'
Pinus strobus 'Prostrata'
Pinus strobus 'Pumila'
Pinus strobus 'Radiata'
Pinus strobus 'Umbraculifera'
Pinus sylvestris, Scots Pine, Scotch Pine
Pinus sylvestris 'Argentea'
Pinus sylvestris 'Argentea Compacta'
Pinus sylvestris 'Beauvronensis'
Pinus sylvestris 'Compressa'
Pinus sylvestris 'Fastigiata'
Pinus sylvestris 'Pendula'
Pinus sylvestris var. rigensis, Riga Pine
Pinus sylvestris 'Watereri'
Pinus tabuliformis, Chinese Pine
Pinus thunbergiana, Japanese Black Pine
Pinus torreyana, Torrey Pine
Pinus virginiana, Virginia Pine, Jersey Pine, Spruce Pine
Pinus wallichiana, Himalayan White Pine, Blue Pine, Bhutan Pine

Source: An Annotated Checklist of Woody Ornamental Plants of California, Oregon, & Washington, Division of Agricultural Sciences, University of California. Publication 4091. February 1979.

APPENDIX X

Volume and Value of Major Lumber-type Pines in California

Lumber Type	National Forests	Other
Ponderosa & Jeffrey Pine		
bd. ft.	31.3 billion	14.1 billion
(at $300/1,000 bd. ft.)	$ 9.4 billion	$ 4.2 billion
Sugar Pine		
bd. ft.	14.7 billion	4.9 billion
(at $470/1,000 bd. ft.)	$ 6.9 billion	$ 2.1 billion
Total		
bd. ft.	46.0 billion	19.0 billion
dollar value	$ 16.3 billion	$ 6.3 billion
Total All Lands	65.0 billion bd. ft.	
	$ 22.6 billion	

Standing volume (1975) and current (1986) standing value as sawtimber.

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